Photometry and Radiometry, United Kingdom, NPL (National Physical laboratory)

Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty					Comments	
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**		
Luminous intensity	Tungsten lamp	Photometric bench and reference lamps / photometer	1	10000	cd	Colour temperature	2000 K to 2856 K	0.5 to 0.4, varies with colour temperature	%	2	95%	Yes		
Luminous intensity	Tungsten lamp	Photometric bench and reference lamps / photometer	1	10000	cd	Colour temperature	2856 K to 3200 K	0.4 to 0.5, varies with colour temperature	%	2	95%	Yes		
Illuminance responsivity, tungsten source	Illuminance meter	Photometric bench and reference lamps / photometer			A/lx	Illuminance	0.1 lx to 5 lx	0.5 to 0.4, varies with illuminance	%	2	95%	Yes		
						Colour temperature	2700 K to 3200 K							
Illuminance responsivity, tungsten source	Illuminance meter	Photometric bench and reference lamps / photometer			A/lx	Illuminance	5 lx to 500 lx	0.4	%	2	95%	Yes		
						Colour temperature	2700 K to 3200 K							
Illuminance responsivity, tungsten source	Illuminance meter	Photometric bench and reference lamps / photometer			A/lx	Illuminance	500 lx to 50000 lx	0.4 to 0.5, varies with illuminance	%	2	95%	Yes		
						Colour temperature	2700 K to 3200 K							
Luminous flux	Tungsten lamp	Integrating sphere or goniophotometer	1	100	lm	Colour temperature	2000 K to 3200 K	0.7 to 0.6, varies with measurand	%	2	95%	Yes		
Luminous flux	Tungsten lamp	Integrating sphere or goniophotometer	100	20000	lm	Colour temperature	2000 K to 3200 K	0.6	%	2	95%	Yes		
Illuminance	Tungsten lamp	Photometric bench and reference lamps / photometer	0.1	50000	lx	Correlated colour temperature	2000 K to 3200 K	0.5	%	2	95%	Yes		
Luminance	Tungsten-based source	Telephotometer and reference lamp / calibrated diffuser combination	1	20000	cd/m^2	Correlated colour temperature	2700 K to 3200 K	1.0	%	2	95%	Yes		
Luminance responsivity	Luminance meter	Reference lamp / diffuser combination			$A/(cd/m^2)$	Luminance	1E-04 cd/m^2 to 1 cd/m^2	1.5	%	2	95%	Yes		
						Type of source used	tungsten reference lamp / diffuser combination							

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Luminance responsivity	Luminance meter	Reference lamp / diffuser combination			A/(cd/m^2)	Luminance	1 cd/m^2 to 20000 cd/m^2	1.0	%	2	95%	Yes	Other types of source can also be used	
						Type of source used	tungsten reference lamp / diffuser combination							
Responsivity, spectral, power	Broadband detector	Double grating monochromator			A/W or V/W	Wavelength	200 nm to 210 nm	3.2	%	2	95%	Yes		
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, power	Broadband detector	Double grating monochromator			A/W or V/W	Wavelength	211 nm to 239 nm	1.0	%	2	95%	Yes		
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, power	Broadband detector	Double grating monochromator			A/W or V/W	Wavelength	240 nm to 404 nm	0.5	%	2	95%	Yes		
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, power	Broadband detector	Double grating monochromator			A/W or V/W	Wavelength	405 nm to 919 nm	0.1	%	2	95%	Yes		
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, power	Broadband detector	Double grating monochromator			A/W or V/W	Wavelength	920 nm to 1600 nm	0.5	%	2	95%	Yes		
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, irradiance	Broad band detector	Double grating monochromator			A/(W/m^2) or V/(W/m^2)	Wavelength	200 nm to 210 nm	3.2	%	2	95%	Yes	Other types of detector can also be calibrated	
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, irradiance	Broad band detector	Double grating monochromator and reference detectors			A/(W/m^2) or V/(W/m^2)	Wavelength	211 nm to 239 nm	1	%	2	95%	Yes	Other types of detector can also be calibrated	
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, irradiance	Broad band detector	Double grating monochromator and reference detectors			A/(W/m^2) or V/(W/m^2)	Wavelength	240 nm to 404 nm	0.5	%	2	95%	Yes	Other types of detector can also be calibrated	
						Bandwidth	< 10 nm							
						Power level	< 20 µW							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty					Comments	
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**		
Responsivity, spectral, irradiance	Broad band detector	Double grating monochromator and reference detectors			A/(W/m^2) or V/(W/m^2)	Wavelength	405 nm to 919 nm	0.1	%	2	95%	Yes	Other types of detector can also be calibrated	
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, irradiance	Broad band detector	Double grating monochromator and reference detectors			A/(W/m^2) or V/(W/m^2)	Wavelength	920 nm to 1600 nm	0.5	%	2	95%	Yes	Other types of detector can also be calibrated	
						Bandwidth	< 10 nm							
						Power level	< 20 µW							
Responsivity, spectral, irradiance	Spectroradiometer	Tungsten or deuterium reference lamps			A/(W/m^2)/nm or V/(W/m^2)/nm or Reading/(W/m^2)/nm	Wavelength range	200 nm to 400 nm	7.3 to 3.2, varies with wavelength	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2)/nm							
Responsivity, spectral, irradiance	Spectroradiometer	Tungsten reference lamps			A/(W/m^2)/nm or V/(W/m^2)/nm or Reading/(W/m^2)/nm	Wavelength range	400 nm to 700 nm	1.9	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2)/nm							
Responsivity, spectral, irradiance	Spectroradiometer	Tungsten reference lamps			A/(W/m^2)/nm or V/(W/m^2)/nm or Reading/(W/m^2)/nm	Wavelength range	700 nm to 2500 nm	2.2 to 18, varies with wavelength	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2)/nm							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Responsivity, spectral, radiance	Spectroradiometer	Tungsten or deuterium reference sources			A/(W/m^2/sr)/nm or V/(W/m^2/sr)/nm or Reading/(W/m^2/sr)/nm	Wavelength range	200 nm to 400 nm	9.5 to 2, varies with wavelength	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2/sr)/nm							
Responsivity, spectral, radiance	Spectroradiometer	Tungsten reference sources			A/(W/m^2/sr)/nm or V/(W/m^2/sr)/nm or Reading/(W/m^2/sr)/nm	Wavelength range	400 nm to 700 nm	2	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2/sr)/nm							
Responsivity, spectral, radiance	Spectroradiometer	Tungsten reference sources			A/(W/m^2/sr)/nm or V/(W/m^2/sr)/nm or Reading/(W/m^2/sr)/nm	Wavelength range	700 nm to 2500 nm	2 to 18, varies with wavelength	%	2	95%	Yes	Other types of source can also be used	
						Bandwidth	> 0.1 nm							
						Power level	< 0.3 (W/m^2/sr)/nm							
Responsivity, laser, power	Laser power meter	Monochromator or laser with reference detectors			A/W or V/W	Wavelength	250 nm to 5000 nm	0.5	%	2	95%	Yes	Other types of detector can also be calibrated	
						Power level	100 pW to 10 mW							
Responsivity, laser, power	Laser power meter	Monochromator or laser with reference detectors			A/W or V/W	Wavelength	9 µm to 11 µm	1	%	2	95%	Yes	Other types of detector can also be calibrated	
						Power level	100 pW to 10 mW							
Responsivity, laser, power	General detector	Laser or narrow band filter with reference detectors			A/W or V/W	Wavelength	350 nm to 1600 nm	0.04	%	2	95%	Yes	Other types of detector can also be calibrated	Approved on 07 May 2007
						Power level	100 pW to 1 mW							
Responsivity, laser, energy	General detector	Laser and reference meters			A/J or V/J or Reading/J	Wavelength	532 nm	2	%	2	95%	Yes	Other types of detector can also be calibrated	

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Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
						Energy level	3E-03 J to 1.1 J							
						Type of detector	laser energy meter							
Responsivity, laser, energy	General detector	Laser and reference meters			A/J or V/J or Reading/J	Wavelength	1064 nm	1.3	%	2	95%	Yes	Other types of detector can also be calibrated	
						Energy level	3E-03 J to 1.1 J							
						Type of detector	laser energy meter							
Irradiance, spectral	Tungsten lamp	Spectroradiometer	3E-05	3E-02	$(W/m^2)/nm$	Wavelength	300 nm to 400 nm	1.3	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Irradiance, spectral	Tungsten lamp	Spectroradiometer	5E-04	2.5E-01	$(W/m^2)/nm$	Wavelength	400 nm to 700 nm	1.3 to 0.6 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Irradiance, spectral	Tungsten lamp	Spectroradiometer	6E-03	2.7E-01	$(W/m^2)/nm$	Wavelength	700 nm to 804 nm	0.5	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Irradiance, spectral	Tungsten lamp	Spectroradiometer	1.5E-03	2.9E-01	$(W/m^2)/nm$	Wavelength	804 nm to 2500 nm	0.5 to 2.4 (with wavelength but not linearly)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Irradiance, spectral	Deuterium lamp	Spectroradiometer	1E-04	2.2E-03	$(W/m^2)/nm$	Wavelength	200 nm to 350 nm	7.3 to 3.3, varies with wavelength	%	2	95%	Yes		
						Bandwidth	1 nm to 2 nm							
Irradiance, spectral	Deuterium lamp	Spectroradiometer	4E-05	3.0E-04	$(W/m^2)/nm$	Wavelength	350 nm to 400 nm	3.3 to 3.2, varies with wavelength	%	2	95%	Yes		
						Bandwidth	1 nm to 2 nm							
Radiance, spectral	Tungsten lamp	Spectroradiometer	1E-05	0.1	$(W/m^2/sr)/nm$	Wavelength range	300 nm to 314 nm	2.1	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiance, spectral	Tungsten lamp	Spectroradiometer	1E-05	1	$(W/m^2/sr)/nm$	Wavelength range	315 nm to 459 nm	1.5	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							

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Radiance, spectral	Tungsten lamp	Spectroradiometer	1E-04	1	$(W/m^2/sr)/nm$	Wavelength range	460 nm to 699 nm	1.3 to 0.8 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiance, spectral	Tungsten lamp	Spectroradiometer	1E-04	1	$(W/m^2/sr)/nm$	Wavelength range	700 nm to 800 nm	0.7	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiance, spectral	Tungsten lamp	Spectroradiometer	1E-04	1	$(W/m^2/sr)/nm$	Wavelength range	801 nm to 2000 nm	1.7 to 2.6, varies with wavelength	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiance, spectral	Tungsten lamp	Spectroradiometer	5E-04	1	$(W/m^2/sr)/nm$	Wavelength range	2001 nm to 2500 nm	3.2	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiance, spectral	Deuterium lamp	Spectroradiometer	10	300	$(W/m^2/sr)/nm$	Wavelength range	200 nm to 350 nm	9.5 to 4.1, varies with wavelength	%	2	95%	Yes	Other types of source can also be measured	
						Bandwidth	1 nm to 2 nm							
Radiance, spectral	Deuterium lamp	Spectroradiometer	10	50	$(W/m^2/sr)/nm$	Wavelength range	350 nm to 400 nm	4.1 to 3.9, varies with wavelength	%	2	95%	Yes	Other types of source can also be measured	
						Bandwidth	1 nm to 2 nm							
Radiant intensity, spectral	Tungsten lamp	Spectroradiometer	3E-05	3E-02	(W/sr)/nm	Wavelength	296 nm to 400 nm	1.3	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiant intensity, spectral	Tungsten lamp	Spectroradiometer	5E-04	2.5E-01	(W/sr)/nm	Wavelength	400 nm to 700 nm	1.3 to 0.6 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiant intensity, spectral	Tungsten lamp	Spectroradiometer	6E-03	2.7E-01	(W/sr)/nm	Wavelength	700 nm to 804 nm	0.5	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							
Radiant intensity, spectral	Tungsten lamp	Spectroradiometer	1.5E-03	2.9E-01	(W/sr)/nm	Wavelength	804 nm to 2500 nm	0.5 to 2.4 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	< 20 nm							

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Radiant intensity, spectral	Deuterium lamp	Spectroradiometer	1E-04	2.2E-03	(W/sr)/nm	Wavelength	200 nm to 350 nm	7.3 to 3.3 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	1 nm to 2 nm							
Radiant intensity, spectral	Deuterium lamp	Spectroradiometer	1.5E-03	2.9E-01	(W/sr)/nm	Wavelength	350 nm to 400 nm	3.3 to 3.2 (with wavelength)	%	2	95%	Yes	Other types of source can also be measured	Approved on 07 May 2007
						Bandwidth	1 nm to 2 nm							
Transmittance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1E-03	1		Wavelength	200 nm to 209 nm	2.7E-05 to 1.6E-03, varies as the logarithm of the measurand		2	95%	No		
						Bandwidth	< 3 nm							
Transmittance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1E-03	1		Wavelength	210 nm to 219 nm	4E-05 to 6E-04, varies as the logarithm of the measurand		2	95%	No		
						Bandwidth	< 3 nm							
Transmittance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1E-03	1		Wavelength	220 nm to 249 nm	3E-05 to 4E-04, varies as the logarithm of the measurand		2	95%	No		
						Bandwidth	< 3 nm							
Transmittance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1E-03	1		Wavelength	250 nm to 749 nm	3E-05 to 3.5E-04, varies as the logarithm of the measurand		2	95%	No		
						Bandwidth	< 3 nm							
Transmittance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1E-03	1		Wavelength	750 nm to 2500 nm	1E-05 to 4.5E-04, varies as the logarithm of the measurand		2	95%	No		
						Bandwidth	< 3 nm							

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Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	3990 cm^{-1}	0.0017 at 0.73		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	3512 cm^{-1}	0.00065 at 0.14		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	3031 cm^{-1}	0.0011 at 0.36		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							

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Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**		
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	2739 cm^{-1}	0.00052 at 0.06		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	2598 cm^{-1}	0.00079 at 0.17		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							

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Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	2473 cm^{-1}	0.00064 at 0.10		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, regular, spectral	Spectrally-neutral material	Scanning spectrophotometer	1E-03	1		Wavenumber	2010 cm^{-1}	0.0001 at 0.0001		2	95%	No	Other types of material can also be calibrated. Uncertainties at other transmittance values available on request	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 15 cm^{-1}							
						Specific measurement conditions	measured at 5 ° and f/6. Values calculated for normal incidence and a range of f/n's.							
Transmittance, diffuse, spectral	Spectrally-neutral material	Spectrophotometer with integrating sphere accessory	0	1		Wavelength range	200 nm to 800 nm	0.01		2	95%	No	Other types of material can also be calibrated	
						Bandwidth	0.5 nm to 2 nm							
						Specific measurement conditions	0/d							
Transmittance, diffuse, spectral	Spectrally-neutral material	Spectrophotometer with integrating sphere accessory	0	1		Wavelength range	800 nm to 2500 nm	0.01		2	95%	No	Other types of material can also be calibrated	
						Bandwidth	2 nm to 20 nm							

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						Specific measurement conditions	0/d							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.05	0.22		Wavelength range	200 nm to 209 nm	0.0008 to 0.0007		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.05	0.22		Wavelength range	210 nm to 219 nm	0.0003 to 0.0004		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.05	0.22		Wavelength range	220 nm to 249 nm	0.0002		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.05	0.22		Wavelength range	250 nm to 749 nm	0.0002 to 0.0001		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.05	0.22		Wavelength range	750 nm to 2500 nm	0.0002		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.22	0.5		Wavelength range	200 nm to 209 nm	0.0007 to 0.0010		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?	Comments	
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.22	0.5		Wavelength range	210 nm to 219 nm	0.0004		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.22	0.5		Wavelength range	220 nm to 249 nm	0.0003		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.22	0.5		Wavelength range	250 nm to 749 nm	0.0001 to 0.0002		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.22	0.5		Wavelength range	750 nm to 2500 nm	0.0002 to 0.0004		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.5	1		Wavelength range	200 nm to 209 nm	0.0010 to 0.0017		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.5	1		Wavelength range	210 nm to 219 nm	0.0004 to 0.0009		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty					Comments	
Quantity	Instrument or Artifact	Instrument Type or Method	Minimum value	Maximum value	Units	Parameter	Specifications	Value	Units	Coverage factor	Level of Confidence	Is the expanded uncertainty a relative one?		
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.5	1		Wavelength range	220 nm to 249 nm	0.0003 to 0.0006		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.5	1		Wavelength range	250 nm to 749 nm	0.0002 to 0.0005		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	0.5	1		Wavelength range	750 nm to 2500 nm	0.0004 to 0.0013		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1	2		Wavelength range	200 nm to 209 nm	0.0017 to 0.0117		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1	2		Wavelength range	210 nm to 219 nm	0.0009 to 0.0026		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1	2		Wavelength range	220 nm to 249 nm	0.0006 to 0.0022		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1	2		Wavelength range	250 nm to 749 nm	0.0005 to 0.0022		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Absorbance, regular, spectral	Spectrally-neutral material	Reference spectrophotometer	1	2		Wavelength range	750 nm to 2500 nm	0.0013 to 0.0043		2	95%	No	Other types of material can be calibrated	Approved on 07 May 2007
						Bandwidth	< 4 nm							
						Specific measurement conditions	CIE geometries							
Reflectance, diffuse, spectral	Spectrally-neutral material	Reference reflectometer	0	1		Wavelength range	350 nm to 1000 nm	0.003		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
						Bandwidth	< 20 nm							
						Specific measurement conditions	spatial integration							
Reflectance, regular, spectral	Spectrally-neutral material	Reference reflectometer	0.003	1		Wavelength range	320 nm to 1600 nm	1.50E-05		2	95%	No	Other types of material can also be calibrated	
						Bandwidth	< 20 nm							
						Specific measurement conditions	as required							
Reflectance, regular, spectral	General material	Spectrophotometer with V-only reflectometer	0	1		Wavenumber range or wavelength range	4000 cm^{-1} to 180 cm^{-1} or 2.5 µm to 56 µm	0.001 to 0.003		2	95%	No		Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
						Specific measurement conditions	10 °							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Reflectance, regular, spectral	General material	Spectrophotometer with variable angle reflectometer	0	1		Wavenumber range or wavelength range	4000 cm^{-1} to 180 cm^{-1} or 2.5 µm to 56 µm	0.0003 to 0.006 (depending on polarisation and angle)		2	95%	No		Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
						Specific measurement conditions	10 ° to 85 °							
Reflectance, hemispherical, spectral	Spectrally-neutral material	Spectrophotometer with hemispherical reflectometer	0	1		Wavelength range	4000 cm^{-1} to 180 cm^{-1}	4E-03 to 3.8E-04, varies with wavenumber		2	95%	No	Other types of material can also be calibrated	
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
						Specific measurement conditions	hemispherical reflectometer							
Emittance, spectral	General material	Spectrophotometer with reflectometer	0	1		Wavelength range	4000 cm^{-1} to 180 cm^{-1}	0.003 to 0.001, varies with wavenumber		2	95%	No	Regular reflectance measurements	Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
						Specific measurement conditions	regular reflectometer							
Emittance, spectral	General material	Spectrophotometer with reflectometer	0	1		Wavelength range	4000 cm^{-1} to 180 cm^{-1}	0.04 to 0.004, varies with wavenumber		2	95%	No		
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
						Specific measurement conditions	hemispherical reflectometer							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
BRDF	General material	Reference reflectometer	0.0008	1000	sr^{-1}	Wavelength range	350 nm to 400 nm	0.00003 + 0.0034*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							
BRDF	General material	Reference reflectometer	0.0003	1000	sr^{-1}	Wavelength range	400 nm to 1000 nm	0.00003 + 0.0019*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							
Reflectance factor	General material	Reference reflectometer	0.25	300000	%	Wavelength range	350 nm to 400 nm	0.01% + 0.0034*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Reflectance factor	General material	Reference reflectometer	0.1	300000	%	Wavelength range	400 nm to 1000 nm	0.01% + 0.0019*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							
Radiance factor	General material	Reference reflectometer	0.25	300000	%	Wavelength range	350 nm to 400 nm	0.01% + 0.0034*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							
Radiance factor	General material	Reference reflectometer	0.1	300000	%	Wavelength range	400 nm to 1000 nm	0.01% + 0.0019*R*		2	95%	No	Uncertainty values are for 0/45 geometry and white Spectralon; Uncertainty varies with scattering geometry and angular dependence of scattering properties of material	Approved on 07 May 2007
						Bandwidth	10 nm to 20 nm							
Wavelength	Spectrally-selective transmitting material	Scanning spectrophotometer	200	2500	nm	Wavelength range	200 nm to 2500 nm	0.1	nm	2	95%	No		Approved on 07 May 2007

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
						Bandwidth	0.1 nm to 5 nm							
Wavenumber	Spectrally-selective transmitting material	Scanning spectrophotometer	1028	3060	1/cm	Wavenumber values	3060 cm^{-1}, 2850 cm^{-1}, 1943 cm^{-1}, 1601 cm^{-1}, 1583 cm^{-1}, 1154 cm^{-1}, 1028 cm^{-1}	0.2 to 0.3 (depending on wavenumber)	cm^{-1}	2	95%	No		Approved on 07 May 2007
						Bandwidth	2 cm^{-1} to 10 cm^{-1}							
Correlated colour temperature	Tungsten lamp	Reference lamps and colorimeter	2000	3200	K			10	K	2	95%	No	Other types of source can also be calibrated	
Correlated colour temperature response	Colour temperature meter	Tungsten reference lamps			reading/K	Correlated colour temperature	2000 K to 3200 K	10	K	2	95%	No	Calibrations can also be carried out at correlated colour temperatures used for visual displays e.g. 6500 K	Approved on 07 May 2007
Colour, emitted, x, y	General source	Spectroradiometer and reference lamps	0	0.9		Bandwidth	< 20 nm	0.0008 to 0.0001, varies with measurand		2	95%	No	The uncertainty varies according to the source properties; the quoted uncertainty applies for tungsten sources. Results can also be expressed in other units e.g. u, v or Lab	
						Type of source	any source, including displays							
Colour, emitted, u, v	General source	Spectroradiometer and reference lamps	0	0.9		Bandwidth	< 20 nm	0.0004		2	95%	No	Uncertainty varies according to source properties. Results can also be expressed in other units e.g. x, y or Lab	Approved on 07 May 2007
						Type of source	any source, including displays							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Colour, emitted, u, v	General source	Spectroradiometer and reference lamps	0	0.9		Bandwidth	selected to suit source type	0.0001		2	95%	No	Uncertainty varies according to source properties. Results can also be expressed in other units e.g. x, y or Lab	Approved on 07 May 2007
						Type of source	any source, including displays							
Colour, emitted, u', v'	General source	Spectroradiometer and reference lamps	0	0.9		Bandwidth	< 20 nm	0.0004		2	95%	No	Uncertainty varies according to source properties. Results can also be expressed in other units e.g. x, y or Lab	Approved on 07 May 2007
						Type of source	any source, including displays							
Colour, emitted, u', v'	General source	Spectroradiometer and reference lamps	0	0.9		Bandwidth	selected to suit source type	0.0001		2	95%	No	Uncertainty varies according to source properties. Results can also be expressed in other units e.g. x, y or Lab	Approved on 07 May 2007
						Type of source	any source, including displays							
Colour, surface, x, y, Y	General material	Integrating sphere spectrophotometer	x, y = 0	x, y = 0.9		Specific measurement conditions	0/d, 2 nm bandwidth	0.0002		2	95%	No		Approved on 07 May 2007
						Type of material	non-fluorescent							
Colour, surface, x, y, Y	General material	Integrating sphere spectrophotometer	Y = 0	Y = 1		Specific measurement conditions	0/d, 2 nm bandwidth	0.0005 + 0.0035Y		2	95%	No		Approved on 07 May 2007
						Type of material	non-fluorescent							
Colour, surface, x, y, Y	Fluorescent material	Reference spectrofluorimeter	x, y = 0	x, y = 0.9		Type of source used	monochromator	0.003		2	95%	No		Approved on 07 May 2007
						Specific measurement conditions	0/45							
						Type of fluorescent material	general							

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Colour, surface, x, y, Y	Fluorescent material	Reference spectrofluorimeter	Y = 0	Y = 300		Type of source used	monochromator	0.003		2	95%	No		Approved on 07 May 2007
						Specific measurement conditions	0/45							
						Type of fluorescent material	general							
Colour, surface, x, y, Y	Diffusely reflecting material	Integrating sphere spectrophotometer	x, y = 0	x, y = 0.9		Specific measurement conditions	0/d, 2 nm bandwidth	0.0002		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
Colour, surface, x, y, Y	Diffusely reflecting material	Integrating sphere spectrophotometer	Y = 0	Y = 1		Specific measurement conditions	0/d, 2 nm bandwidth	0.0005 + 0.0035Y		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
Colour, surface, L*a*b*	General material	Integrating sphere spectrophotometer	L* = 0	L* = 100		Specific measurement conditions	0/d, 2 nm bandwidth	0.15		2	95%	No		Approved on 07 May 2007
						Type of material	non-fluorescent							
Colour, surface, L*a*b*	General material	Integrating sphere spectrophotometer	a*, b* = -200	a*, b* = 200		Specific measurement conditions	0/d, 2 nm bandwidth	0.1		2	95%	No		Approved on 07 May 2007
						Type of material	non-fluorescent							
Colour, surface, L*a*b*	Fluorescent material	Reference spectrofluorimeter	L* = 0	L* = 160		Irradiation conditions	monochromator	0.003		2	95%	No		Approved on 07 May 2007
						Specific measurement conditions	0/45							
						Type of fluorescent material	general							
Colour, surface, L*a*b*	Fluorescent material	Reference spectrofluorimeter	a*, b* = -200	a*, b* = 200		Irradiation conditions	monochromator	1.2		2	95%	No		Approved on 07 May 2007
						Specific measurement conditions	0/45							
						Type of fluorescent material	general							
Colour, surface, L*a*b*	Diffusely reflecting material	Integrating sphere spectrophotometer	L* = 0	L* = 100		Specific measurement conditions	0/d, 2 nm bandwidth	0.15		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Colour, surface, L*a*b*	Diffusely reflecting material	Integrating sphere spectrophotometer	a*, b* = -200	a*, b* = 200		Specific measurement conditions	0/d, 2 nm bandwidth	0.1		2	95%	No	Other types of material can also be calibrated	Approved on 07 May 2007
Colour, transmitted, x, y, Y	General material	Spectrophotometer	x, y = 0	x, y = 0.9		Specific measurement conditions	regular transmittance geometry	0.0002		2	95%	No		
						Type of material	non-fluorescent							
Colour, transmitted, x, y, Y	General material	Spectrophotometer	Y = 0	Y = 1		Specific measurement conditions	regular transmittance geometry	0.003		2	95%	No		
						Type of material	non-fluorescent							
Colour, transmitted, L*a*b*	General material	Spectrophotometer	L* = 0	L* = 100		Specific measurement conditions	regular transmittance geometry	0.05		2	95%	No		
						Type of material	non-fluorescent							
Colour, transmitted, L*a*b*	General material	Spectrophotometer	a*, b* = -200	a*, b* = 200		Specific measurement conditions	regular transmittance geometry	0.05		2	95%	No		
						Type of material	non-fluorescent							
Responsivity	Fibre optic power meter	Comparison with reference detector			Reading/W	Wavelength	850 nm	1.0	%	2	95%	Yes		
						Bandwidth	< 1 nm							
Responsivity	Fibre optic power meter	Comparison with reference detector			Reading/W	Wavelength	1300 nm	1.0	%	2	95%	Yes		
						Bandwidth	< 1 nm							
Responsivity	Fibre optic power meter	Comparison with reference detector			Reading/W	Wavelengths	1480 nm to 1570 nm	1.0	%	2	95%	Yes		
						Bandwidth	< 1 nm							
Wavelength	Fibre optic source	Spectrum analyser	800	1700	nm			0.3	nm	2	95%	No		

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Calibration or Measurement Service			Measurand Level or Range			Measurement Conditions/Independent Variable		Expanded Uncertainty						
Quantity	**Instrument or Artifact**	**Instrument Type or Method**	**Minimum value**	**Maximum value**	**Units**	**Parameter**	**Specifications**	**Value**	**Units**	**Coverage factor**	**Level of Confidence**	**Is the expanded uncertainty a relative one?**	**Comments**	
Wavelength	Optical spectrum analyser	Lamp / wavemeter / transition locked laser	600	1700	nm			34	pm	2	95%	No	Measurements can be made at specified wavelengths within this range, depending on the availability of a suitable laser source. The uncertainty will depend on the properties of the OSA under calibration.	